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APPLICATION FOR USE OF ERTS-A FOR
RETRANSMISSION OF WATER RESOURCES DATA
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15. Abstract <p>Water Resources data were retransmitted from nine DCPs located in remote regions of Canada. The DCPs located in the Arctic operated in temperatures lower than -40°C and the DCP antennas have survived wind speeds of greater than 80 kph and snow loads of a depth of one metre.</p> <p>Ice-out indicators were installed at a few DCP sites. The purpose of these indicators was to enable the detection of the movement of ice out of a river channel during spring break-up.</p> <p>The suitability of satellite retransmission as a means of obtaining data from remote areas of Canada continues to be demonstrated. A modest expansion of the DCP network is planned.</p>		

Water Survey of Canada: Application for Use
of ERTS-A for Retransmission of Water
Resources Data

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Type II Report for the Period June 1973 - July 1974

PREFACE

The purpose of the investigation is to use ERTS Data Collection Platforms (DCPs) to collect water level readings and other related water resources data several times daily from each of the nine gauging stations and to use this information for operational purposes. In this way, the dependability, costs and other aspects of the whole system will be studied and decisions made with respect to the feasibility and advantages of establishing a much larger network of DCPs dependent on future satellite facilities.

Nine DCPs have been used to transmit water level data from sites in northern and western regions of Canada. Other data transmitted from some locations include precipitation, air temperature, water velocity, "ice-out" indication, DCP battery voltage, and water stage recorder operation check. Data were used both for water management purposes for planning of hydro-metric field activities:

During the twelve month period June, 1973 to July, 1974, approximately 30,000 transmissions were received from the nine stations. Quality checks indicate that the data received are reliable.

DCP 6260 failed in 1973. At first the failure was attributed to an error in reconnecting the platform at a new temporary location. Now it is believed that the failure was caused by lightning or some other phenomenon.

On the basis of experience to date, it can be concluded that water resources data can be transmitted reliably at reasonable cost by satellite.

Type II Progress Report for the Period
July, 1973 to July, 1974

The Water Survey of Canada operates over 2400 gauging stations at which water level data are collected. At most stations, the water level data are used to compute river discharge data. These data are used for river flow and flood forecasting, water level forecasting for navigation, and planning of hydrometric field surveys. In many instances, it would be desirable to obtain data on a near real time basis, however, because of the isolated locations of most of the gauging stations, the cost of doing this has been prohibitive.

Therefore, when the ERTS Data Collection System was proposed, it seemed worthwhile to investigate the possibility of using a satellite retransmission system to collect discrete water level readings at least once daily from a few gauging stations and to use this data for operational purposes. In this way, a valid assessment regarding reliability, costs and other aspects of the whole system could be studied and decisions made with respect to the feasibility and advantages of establishing a much larger network of DCPs dependent on future satellite facilities. The sites were selected to give a wide range in climatic and areal conditions.

Nine sites were selected for an experiment with data relay by ERTS spacecraft. Since the original selection was made, several of the DCPs have been relocated to more strategic locations for forecasting of water levels and river flow. Table One lists the present location of DCPs.

The sites were selected on the basis that real time data would be very valuable for flow and flood forecasting and other operational purposes and that severe climatic conditions at the site would provide a good test of the DCPs performance.

Water levels are sensed at Water Survey of Canada gauging stations by a float and pulley or by pressure sensing manometers that sense the static pressure in a nitrogen gas purge system. The water level is usually recorded on a strip chart recorder. At those stations where ERTS DCPs are installed, an analogue to digital shaft encoder is connected to the water level sensor. This encoder (the Leupold & Stevens Memomark II) stores 16 bits of data (4 BCD digits) and is connected directly to the

Table One

Location of Data Collection Platforms

<u>I.D.</u>	<u>Station Name</u>	<u>Lat.</u>	<u>Long.</u>
6126	Duncan River Below B.B. Creek	50° 38'	117° 03'
6232	Nahatlatch River Below Tachewana Creek	49° 57'	121° 52'
6354	McGregor River at Lower Canyon	54° 14'	121° 40'
6260	Mackenzie River near Wrigley	63° 16'	123° 36'
6366	Mackenzie River at Sans Sault Rapids	65° 46'	128° 45'
6150	Lake Athabasca at Cracking- stone Point	59° 23'	108° 53'
6353	Kazan River at Outlet of Ennadai Lake	61° 15'	100° 58'
6102	Albany River above Nottick Island	51° 38'	86° 24'
6137	Winisk River below Asheweig River Tributary	54° 31'	87° 14'

parallel digital plug on the DCP.

Since several of the DCPs were installed in areas where temperatures of -50°C can occur, a few shelters housing the DCPs and sensors were heated using a catalytic propane heater equipped with a 630 kJ orifice. Prior to installation of the heater, an insulated compartment is constructed around the DCP and sensor. Two DCPs that were left unheated transmitted data without apparent adverse effects from severe temperatures.

Two different types of ice-out indicators were constructed and tested for use with the DCPs.

The Mark I which is no longer used requires an eight bit analogue word while the Mark II uses one bit in a parallel digital word. Both indicators operate on the same principle and are designed to detect large movements of river ice. This is done by tying a friction type connector such as a Cinch-Jones near the water's edge so that when major ice movement occurs, lines embedded in the ice pull the plug apart causing the message transmitted by the DCP to change.

The Mark II indicator uses a plug that is shorted on one side. Lines to this side of the plug are embedded in the river ice; the other

side of the connector is connected to a parallel digital bit in the DCP. When the ice is intact, the DCP transmits a zero and when the plug is pulled apart, the DCP transmits a one. One of these indicators was installed at DCP 6102 (Albany River above Nottik Island). Information obtained from the indicators is used to assist in streamflow computations and as an aid to hydrometric operations by knowing when the ice moves out so that a discharge measurement can be made as soon as possible after break-up.

In cooperation with the Atmospheric Environment Service (AES), Department of the Environment, a Hydrometeorological Recording and Telemetering System (HARTS) was installed at DCP 6102 (Albany River above Nottik Island) on October 23, 1973 to encode and store data from a Fischer and Porter precipitation gauge and a platinum resistance bulb thermometer. Accumulated precipitation to the nearest 0.03 m and temperature to the nearest 0.055°C are encoded for transmittal by ERTS. The system has been used by the AES for encoding of snow pillow and wind run anemometer data for retransmittal by ERTS DCS.

A battery check device has been installed at three sites to monitor the voltage level of the DCP power supply. The voltage of the DCP batteries is scaled to provide a voltage less than 5 volts. In order to conserve the DCP batteries, the device is switched on by the data gate signal prior to transmission. The battery check device uses one analogue channel.

The Leupold & Stevens Type A recorder has very good cold temperature performance characteristics but is subject to clock stoppage at about -50°C. Also, the clock stops once in a while for reasons other than cold temperatures. Once stopped, it is very unusual for a clock to restart on its own. A method of checking clock operation using a cam and single throw, double pole micro-switch was devised. When the recorder clock is operating, two parallel digital bits in the DCP message change from 01 to 10 to 01 and so on every 10 hours. A failure to change indicates that the recorder clock has stopped.

During the reporting period, eight DCPs were in operation. The ninth DCP 6260 failed on July 28, 1973. This DCP suffered severe damage to the programmer and analogue boards. It is thought that the damage was caused by lightning or some other phenomenon. Table Two shows the percent usable data received from each platform.

Table Two

Usable Water Level Data from DCPs

<u>Platform ID</u>	<u>Transmissions</u>	<u>Percent Usable</u>	
6126	2304	100	
6232	2312	100	
6354	2952	100	
6260	131	100	Damaged July 28, 1973 caused by lightning.
6366	1345		Turned off for winter months.
6150	5028	75	Sensor problems.
6353	5279	90	Water stage encoder clock stopped.
6102	4884	100	
6137	5611	95	
	<hr/> 29846		

From June 1973, to July 1974, 32,925 messages were received in card form.

A computer program is used to translate the actual readings into engineering units and prints the water level and the time of transmission along with the quality data. For the nine stations operating during the report period, the maximum transmission varied from 25 to 10 and the minimum from 10 to 1 depending on the station. A summary of the transmissions is shown in Table Three. Messages received at the same time at both Goldstone and Goddard are counted once.

Most transmissions were scanned for quality and, in addition, some data were plotted manually on an analogue recorder chart. No incorrect readings were detected. It continues to appear that accumulations of up to one metre of snow on the antenna seem to have no effect on the quality of the data or the number of transmissions received. The antenna ground plane for DCP 6126 was damaged by snow load; this was probably caused by loading of the guywires rather than of the antenna itself.

Since much of the data are used on a near real time basis, arrangements were made by the Canada Centre for Remote Sensing (CCRS) to have all Canadian DCP data received by teletype. The data are received at the Centre by teletype from NASA, converted to engineering units and stored

TABLE THREE

SUMMARY OF RETRANSMITTED DATA

Platform ID	Daily Mean Transmissions per Cycle for Cycles 20 to 40																				Transmissions Daily			
	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	39	39	40	Maximum	Minimum	Total
6126	7	7	8	7	7	7	7	6	7	7	7	7	6	7	7	7	7	8	7	7	6	10	3	2628
6232	8	8	8	8	7	7	7	6	6	5	6	3	6	7	6	6	7	8	7	7	6	12	3	2502
6354	9	9	9	9	8	7	7	7	8	8	7	8	8	8	7	7	8	8	9	8	7	11	3	1821
6260	6	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	2	198
6366	8	8	8	8	8	7	7	6	6	-	-	-	-	-	-	-	-	-	7	7	6	20	3	1548
6150	15	16	16	15	14	14	13	13	13	14	16	14	13	13	13	12	12	14	14	14	14	20	6	5258
6353	16	16	17	16	15	15	14	13	14	14	16	14	13	14	12	13	13	14	15	15	7	25	7	5328
6102	13	14	16	14	14	13	13	13	15	14	16	15	14	14	13	14	13	14	15	15	15	19	3	5364
6137	17	18	18	17	16	15	16	14	15	14	15	14	15	14	13	15	16	16	17	15	-	22	6	5580
TOTAL:																							30,227	

for retrieval by user's teletype. In this way, the data are made available to users with no greater than a 24 hour time delay. Unfortunately, because of land line problems, users in Calgary and Vancouver could not always receive data from the computer at CCRS. When this happened, the data was received at this office in Ottawa and telexed to the users.

On the basis of our results to date, it is apparent that satellite retransmission is an excellent method of obtaining data from isolated areas. In fact, in many parts of Canada, it is the only way to obtain data on a real time basis. Capital costs of the equipment installed at a gauging station are reasonable and indications are that the DCPs do not require much maintenance. As a further test on the use of satellite retransmission for operational monitoring of water resources data, an expansion of the DCP network to 28 is planned. A contract has been let to Ball Brothers Research of Boulder, Colorado for an additional 19 CDCP-100 Data Collection Platforms.